

### **REMARKS**

Upon entry of the above amendment, the claims will be 41-69.

The above amendment presents a new set of claims responsive to points set forth in the Official Action.

The correspondence between the present claims and the previously submitted claims will now be discussed.

<u>Present Claims</u>	<u>Previous Claims</u>
41	1
42	2
43	3
44	4
45	8
46	10
47	12
48	14
49	15
50	16
51	17
52	20
53	28
54	29
55	30
56	31
57	32
58	33
59	36
60	7
61	37
62	38

63	19
64	39
65	40
66	New
67	New
68	New
69	New

In the above claims, claims 41, 48, 53, 59 and 62 (which are based on previous claims 1, 14, 28, 36 and 38, respectively), the phrase "wherein the contaminated matter mixed with the reducing agent and the nutritional liquid has a water content of at least 40% by weight" is inserted. This phrase is supported by the description from page 13, line 28 to page 14, line 3 and of page 28, lines 11-15.

The addition of "the nutritional liquid" is supported by the description of from page 13, line 28 to page 14, line 3, wherein it is disclosed that 15-25% by volume of nutritional liquid is added to the contaminated matter.

A reducing agent is added to the contaminated matter at the same time or after the nutritional liquid is added. In general, soil typically has a water-content of about or more than 30% and, therefore, contaminated matter such as soil will have a water-content of at least 40% by weight after mixing with the nutritional liquid. In addition, Example 2 describes that the water content of the contaminated matter after mixing with the reducing agent and the nutritional liquid ranged from 48 to 53%. Consequently, we believe that the limitation of a water-content of the mixed contaminated matter is supported by the description of the specification.

In the Final Rejection dated July 31, 2002 and the Advisory Action issued on November 8, 2002, the Examiner pointed out that the phrase, "oxidation reduction potential of the contaminated matter is reduced and maintained not more than -350 mV at least 5 days by adding the reducing agent and the nutritional liquid" inserted in claims 1, 13 and 28 constitutes new matter. The phrase is retained in new claims 41, 48 and 53 (which are based on previous claims 1, 14 and 28, respectively).

The phrase is supported by the description of the specification as shown below.

When contaminated matter such as soil is treated by a method defined in the claim 41, 48 or 53, oxidation reduction potential (ORP) of the treated contaminated matter is rapidly decreased to -350 mV or lower by reacting with a mixed reducing agent, within a short period of time such as less than one hour as illustrated in, for example, Examples 6, 7 and 8. In the environment, the decreased ORP will gradually increase because oxidizing substances such as oxygen, nitric acid, etc. are diffused from the surrounding environment into the treated matter.

This is obvious to a person skilled in the art and is reported in "Engineered Approaches for In Situ Bioremediation of Chlorinated Contamination, Battelle 1999" (Reference 1) and "ISEB 2000" (Reference 2). A copy each of these References is enclosed.

From the technical standpoint, the present inventors predicted that it would be important for dehalogenating halogenated organic compounds present in the contaminated matter to maintain a decreased ORP of the treated contaminated matter for at least a certain period of time. In order to test their prediction, the inventors measured the ORP and the concentration of halogenated organic compounds of the treated contaminated matter during the incubation period after the mixing.

The results are shown in every Example in the specification excluding Example 14. These Examples disclose that it is critical to maintain a decreased ORP of the mixed contaminated matter for a long time in order to desirably achieve dehalogenation of halogenated organic compounds to be treated and that the maintenance time should be at least about five days and ORP of not more than -350 mV as shown below.

In particular, as shown in Table 7 in Example 4, Test Run Nos. 4-2 and 4-3 wherein ORP measured on the 60th day from the start of the incubation was not more than -375 mV, exhibited 100% decomposition of tetrachloroethylene (PCE). Since the ORP of the tested systems is retained at not more than -375 mV even after the 60-day incubation, it is reasonable to interpret that the ORP should have been retained at not more than -350 mV for at least 5 days, for example, from the start of the test. As is explained above, ORP of the soil is rapidly decreased by mixing it with a reducing agent and then gradually increased in the environment. In the Example, the ORP to be measured beyond 60 days after the start of the test was not reported. However, if ORP is measured on the 70th day from the start of testing and if the ORP is retained at -350 mV or lower, desirable results will be

obtained. Thus, please note that 60 days or a similar length of time does not constitute an upper-limit for the period wherein ORP should be maintained at a certain level of ORP, but they are sufficient for obtaining the desirable results.

It should be understood that a period of at least five days wherein the ORP is maintained at the certain value is essential.

In contrast, with respect to Test Runs Nos. 4-4 and 4-5, in which the ORP was elevated at -229 mV or more on the 60-day incubation, 64% and 80% of PCE respectively remained without decomposition. This Example implies that there is a critical ORP for sufficient decomposition of PCE at an ORP of between -375 mV and -229 mV.

Similarly, in Table 9 in Example 5, Test Runs Nos. 5-2 and 5-4 had 65% and 58% conversion of PCE, respectively, wherein each of their ORP determined at a time of the 63-day incubation was at not more than -375 mV. On the other hand, No. 5-6, ORP of which is elevated to more than -347 mV indicated decomposition of only 28%. This implies that the criticality of ORP is present around -350 mV.

Similarly, in Table 12 in Example 10, the decomposition ratio of pentachlorophenol (PCP) and the ORP values were determined 20 and 40 days after the start of the Test. The conversion ratio of PCP of Test Run No. 10-1 on the 40th day which had an ORP of -380 mV on the 20th day was 94.3%, while the conversion ratio of PCP of Test Run No. 10-2 on the 40th day which had an ORP of -170 mV on the 20th day was only 76.5%. This Example teaches that in tests that are conducted for a long period of time such as 40 days, if an ORP is determined at not more than -350 mV on a shorter period of time such as 20 days after the start of the test, it is possible to predict the decomposition level regardless of whether it has reached a desirable level or not.

In Table 16 in Example 11, Test Runs Nos. 10-3 and 10-4 exhibited a conversion of PCE to ethylene of 81% or more, wherein each of their ORP on 30-day incubation was at not more than -376 mV. On the other hand, No. 10-2, wherein no nutritional liquid was added, and ORP of which was +2 mV, obtained a conversion of only 26%.

As explained above, in Examples 4, 5, 10 and 11, Test runs, which exhibited ORP of not more than -350 mV and maintained it for at least five days from the start of the test, target halogenated organic compounds in the contaminated matter were efficiently dehalogenated. In these test runs,

it is reasonable to consider that ORP was retained not more than -350 mV during the first 5 days. Especially, the criticality is seen at an ORP of -350 mV as shown in Table 9 in Example 5.

From the data in these Examples, it is considered to be critical that an ORP be maintained at not more than -350 mV for at least five days.

The feature "whereby an oxidation reduction potential of the contaminated matter reduced and maintained not more than +130 mV at least 5 days by adding the liquid" inserted in claims 59 and 62 is supported in the specification.

In Example 9 wherein ascorbic acid was used as a reducing agent, the system (2) showing an ORP of -150 mV after a period of 40 days obtained 99.9% of conversion of PCE to ethylene and ethane. On the other hand, in the system (1) wherein an ORP was +300 mV, only 50% conversion was observed.

Ascorbic acid is a water-soluble reducing agent which has a reactivity higher than that of a water-insoluble reducing agent. Therefore, it is considered that when a water-soluble reducing agent is used, chlorinated organic compounds in a treated contaminated matter are efficiently dehalogenated even if its ORP is of a relatively high value such as at -150 mV.

On the other hand, an ORP of +300 mV was too high to obtain efficient dehalogenation. Thus, it is considered that the criticality of ORP upon using a water-soluble reducing agent such as ascorbic acid resides in between -150 mV and +300 mV.

For these reasons, it is apparent that the above-mentioned feature of claims 59 and 62 is supported by the description of the specification.

With Respect to Rejection under 35 USC 103(a):

1. In the Advisory Action, the Examiner maintained the reasons for the final rejection wherein claims 1-3, 5, 7-20 and 28-40 are obvious from Schuring et al.

Schuring et al. discloses a method for treating contaminated matter in soil by contacting it with dry media as a treating agent, examples of which are generally defined and enumerated therein. However, Schuring et al. fails to provide a specific combination of a specific treating agent with a specific treating process. Schuring et al. discloses that the dry media can include powdery metals or alloys, organic compounds and nutrients capable of accelerating growth of microbes in the treated soil. From these descriptions of Schuring et al, the Examiner judged that claims on file are obvious

from Schuring et al. That is, the Examiner considered that the use of a combination of a reducing agent with a water-soluble nutritional solution for growing heterotrophic anaerobic microorganism in a method for treating soil contaminated with halogenated organic compounds is obvious to a person skilled in the art.

2. A method for chemical dechlorination of chlorinated organic compounds with use of a metal such as iron was patented in 1993 (e.g. U.S. Patent 5,266,213). Further, a method for biological dechlorination of chlorinated organic compounds under anaerobic conditions was patented in 1994 (e.g. U.S. Patent 5,342,769). Before Schuring et al. filed the application in 1996, it was already known (in 1994) that powdery metal or a nutritional composition for accelerating growth of microbes in soil is able to effectively dechlorinate chlorinated organic compounds. However, until the present application was filed in 1997, there was no article or patent disclosing that a combination of the chemical and biological dehalogenation reactions obtained complete dehalogenation of halogenated compounds, such as PCE, adsorbed by the soil.

Development of a chemical dechlorination method had been directed to treatment of groundwater. On the other hand, with respect to the biological method, there were many reports concerned only with how undesirable by-products or toxic intermediate metabolites such as cis-dichloroethylene (cDCE) or vinylchloride (VC) are accumulated.

3. These facts clearly indicate that the benefit of combining the chemical and biological dehalogenation reactions in the present invention is not obvious to a person skilled in the art from the prior art. It is speculated that researchers, except for the present inventors, understood that a combination of a reducing agent such as iron with nutrients for microorganisms would not provide synergistic effects, but give merely additive effects. From the standpoint of the biological method, it would be speculated by a person skilled in the art that the addition of a reducing agent such as iron to the biological process would merely increase the cost without obtaining the desired effects.

Consequently, a practical method for treating soil contaminated with halogenated organic compounds by adding iron powder to the soil or by use of biological method had not been employed by the prior art. In the method of using iron powder, researchers considered that a large amount such as about 5% by weight of iron based on soil should be added to soil because iron is less efficiently contacted with soil. In the biological method, accumulation of toxic intermediate metabolites was a

considerable unresolved problem.

Under the above-explained circumstances, the inventors of the present application, as illustrated in e.g. Example 11, added a combination of a nutritional liquid for microorganism with a small amount such as 0.2% of reducing iron to PCE contaminated soil to obtain unexpectedly good effects. Thus, ORP of the treated soil was maintained at a low value, and chlorinated organic compounds were completely dechlorinated without accumulating toxic intermediate metabolites. Thereby PCE was completely converted to non-toxic ethylene and ethane.

The present inventors discovered and developed the present novel and useful method for treating soil contaminated with halogenated organic compounds. As a result of this method, the inventors succeeded in treating 100,000 m<sup>3</sup> or more soil contaminated with chlorinated organic compounds, thereby successfully converting the soil to a nontoxic one.

For the reasons stated above, the merits of combining chemical and biological methods were unobvious from the prior art and particularly the unexpectedly good results therefrom.

In addition, the inventors first found that a low ORP of the treated soil, which is maintained for a certain period of time is essential to achieve the desirable effects intended in the present invention. All of ORP determined by the test have been described in the specification. Further, the inventors have carried out tests using a variety of alloys as a reducing agent and a water-soluble reducing agent, the results of which are described in Examples 6-9 in the specification.

Schuring et al. does not teach or suggest the facts that chlorinated organic compounds in soil are completely converted to nontoxic material without accumulating toxic intermediate metabolites such as cDCE and VC, thereby converting the contaminated soil to a nontoxic one. It is clear that the present invention could not have been conceived by a person skilled in the art from Schuring et al. For three years from 1994, no practical method for treating contaminated soil had been developed and the inventors of the present invention were the first to invent such method.

Thus, it is apparent that the present invention is unobvious from Schuring et al.

Favorable action on the merits is now requested.

Respectfully submitted,

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